Remarks

Claims 1-3, 7-12, 14, 17-32, and 36-44 of the application were rejected and remain for consideration by the Examiner. Claims 4-6, 13, 15, 16, and 33-35 were withdrawn from consideration by the Examiner as drawn to a nonelected species. The Examiner agreed with Applicant's previous arguments that claim 1 is generic with respect to claims 1-42 and claim 39 is generic with respect to claim 40-42. Claims 1, 24, and 43 are currently amended.

Claims 1 and 43 are amended to require an evaporator that is "substantially" full of liquid coolant rather than "at least partially" full. Support for these amendments may be found at, for example, page 12, lines 11-13 and 18-21, plus Figs. 3 and 6-15 and accompanying text.

Claim 24 is amended to correct a typographical error in the reference from claim 20 to claim 23.

Claim Rejections – 35 USC § 102 – Ghoshal

The Examiner rejected claims 1, 2, 3, 7, 12, 17, 43, and 44 under 35 U.S.C. 102(e) as being anticipated by Ghoshal US Patent No. 6,474,074. In addition to these claims being novel, they are also nonobvious in that there is no *prima facie* case of obviousness.

1. Independent claims 1 and 43

Claims 1 and 43 require that there be a condenser "extending around the periphery of the evaporator." Ghoshal, on the other hand, requires a capillary region 220 in between the evaporator region 210 and condenser region 225. (See Ghoshal Figure 2.) As Ghoshal lacks at least one element of an evaporator having a condenser on its periphery, claims 1 and 43 are not anticipated by Ghoshal.

Nor are claims 1 and 43 obvious in light of Ghoshal. Ghoshal is a heat pipe design that operates by fluid return from the condenser to the evaporator by the wicking action of the capillary action. To remove the capillary region to attempt representing Applicant's invention would change the principle of operation of Ghoshal; claims 1 and 43 are therefore nonobvious and patentable over Ghoshal.

Further, claims 1 and 43, as currently amended, require an evaporator that is "substantially full" of liquid coolant rather than "at least partially full." The liquid coolant, or transport fluid, of Ghoshal, however, only partially fills the evaporator, and Ghoshal does not teach or suggest a substantially full evaporator in any orientation. To the contrary, Ghoshal requires that there be vapor in the evaporator region that is transported by the vapor channels 235 (see col. 4, lines 38-41).

Ghoshal would not function if the transport fluid substantially filled the evaporator region; if it did, not only would there be no void available for vapor in the evaporator, but the condenser region would also be full of transport fluid. Ghoshal lacks the ability to have a substantially full evaporator region, and doing so would render Ghoshal unsatisfactory for its intended purpose. Ghoshal as modified with a substantially full evapo-

rator also has no likelihood of success. Claims 1 and 43 are therefore novel as well and nonobvious over Ghoshal.

2. Dependent claims 2, 3, 7, 12, 17, and 44

Because claims 2, 3, 7, and 12 depend from allowable claim 1 as amended and respectively add limitations thereto, these claims are allowable. Claim 17 depends from claim 12, which depends from claim 1, and is therefore allowable for the same reason. Claim 44 depends from claim 43 and respectively adds limitations thereto, and is similarly allowable. For additional reasons set forth below, claims 7, 12, 17, and 44 are allowable.

2.a. Claim 7

The examiner asserts that Ghoshal discloses a boiling enhancement structure 250 disposed within the evaporator (see figure 2 and column 4 lines 5-15). The boiling enhancement structure of the Applicant's invention is "a porous component that provides re-entrant cavities" (see p. 10, lines 20-21). Ghoshal, however, has "hot point" elements 250, which are disclosed as conically shaped (see col. 4, lines 9-15). Alternatively, they may be pyramidal, or any shape terminating at a tapered point (see col. 4, lines 31-37), and are so required in order to function in accordance with Ghoshal's invention. *"Any configuration may be used as long as the hot points terminate at a tapered point"* (see col. 4, lines 34-36; emphasis added; see also Ghoshal independent claims 1, 21, and 29, all requiring hot point elements). The Ghoshal hot point elements

are structurally and functionally different from Applicant's boiling enhancement structure.

Ghoshal's mechanism of heat transfer is through evaporation of the liquid to vapor. This is aided by increasing the area available for heat transfer through the plurality of elements 250 in the evaporator region 210. In contrast, the primary mode of heat transfer in the present invention is through the boiling enhancement structure 34, which helps mainly in trapping vapor, thereby providing active sites for bubble nucleation.

Further, the evaporation process of Ghoshal is a surface phenomenon and does not involve the formation of vapor bubbles that form in Applicant's invention. This is one reason why there needs to be a thin layer of liquid region in the evaporator section of Ghoshal's device for it to function properly. Excess liquid at high heat fluxes results in bubble formation that might block the capillaries and prevent the return of liquid from the condenser to the evaporator, known as the "boiling limit" in heat pipes, and needs to be avoided in Ghoshal.

Ghoshal's hot point elements are not boiling enhancement structures as defined by Applicant's invention, and the required feature is lacking from Ghoshal. Disclosure of the hot points of Ghoshal does not teach or suggest the use of boiling enhancement structures as required by Applicant's invention, and therefore claim 7 is novel and nonobvious with respect to Ghoshal.

are structurally and functionally different from Applicant's boiling enhancement structure.

Ghoshal's mechanism of heat transfer is through evaporation of the liquid to vapor. This is aided by increasing the area available for heat transfer through the plurality of elements 250 in the evaporator region 210. In contrast, the primary mode of heat transfer in the present invention is through the boiling enhancement structure 34, which helps mainly in trapping vapor, thereby providing active sites for bubble nucleation.

Further, the evaporation process of Ghoshal is a surface phenomenon and does not involve the formation of vapor bubbles that form in Applicant's invention. This is one reason why there needs to be a thin layer of liquid region in the evaporator section of Ghoshal's device for it to function properly. Excess liquid at high heat fluxes results in bubble formation that might block the capillaries and prevent the return of liquid from the condenser to the evaporator, known as the "boiling limit" in heat pipes, and needs to be avoided in Ghoshal.

Ghoshal's hot point elements are not boiling enhancement structures as defined by Applicant's invention, and the required feature is lacking from Ghoshal. Disclosure of the hot points of Ghoshal does not teach or suggest the use of boiling enhancement structures as required by Applicant's invention, and therefore claim 7 is novel and nonobvious with respect to Ghoshal.

2.b. Claim 12

Claim 12 requires that the interior major surfaces of first and second opposing plates define an evaporator volume. These interior major surfaces of claim 12 terminate, for example, at recessed areas that form the condenser/pool belt 30 (FIGS. 1-3, for example and page 8, lines 20-22). Ghoshal discloses otherwise. In Ghoshal, the interior major surfaces of "substrates" 230 and 240 (see Fig. 2) define the entire limits of the apparatus, including an evaporator region 210, a capillary region 220, and a condenser region 225. Ghoshal lacks the required features that define an evaporator region as required by claim 12. Further, Ghoshal neither teaches nor suggests using plates that have major surfaces defining only an evaporator, and therefore claim 7 is novel and nonobvious with respect to Ghoshal.

2.c. Claim 17

Claim 17 recites a thermosyphon that has a full evaporator when horizontal and the first plate is above the second plate. Contrary to the Examiner's assertion, Ghoshal's Figure 2 does not show *any* fluid in the between its first and second substrates 230, 240. Presumably, Ghoshal's evaporator does include some fluid. As discussed above, however, with respect to claim 7 and amended claims 1 and 43 , the liquid coolant, or transport fluid, of Ghoshal only partially fills the evaporator, and Ghoshal does not teach or suggest a substantially full evaporator in any orientation. To the contrary, Ghoshal requires that there be vapor in the evaporator region that is transported by the vapor channels 235 (see col. 4, lines 38-41; col. 5, lines 22-26).

Ghoshal would not function if the transport fluid filled the evaporator region; if it did, not only would there be no void available for vapor in the evaporator, but the condenser region would also be full of transport fluid. Ghoshal lacks the ability to have a full evaporator region, and accordingly would be rendered unsatisfactory for its intended purpose if its evaporator were full. Claim 17 is novel and nonobvious with respect to Ghoshal.

2.d. Claim 44.

Claim 44 provides that there be a void in the evaporator to allow the heat-dissipating element to directly contact the liquid coolant. The Examiner stated that Ghoshal discloses such a void, citing Figures 2 and 3. It is respectfully submitted that the Examiner was incorrect in this assertion. Nowhere in Ghoshal, including Figures 2 and 3, is a void in the evaporator disclosed. Rather, the heat-dissipating element ("chip") is placed in contact with the bottom of the evaporator ("substrate" 240). Ghoshal lacks a void and cannot anticipate claim 44, which is therefore novel. Claim 44 is also nonobvious as Ghoshal does not teach or suggest a modification, nor a motivation to modify, its substrate.

Claim Rejections - 35 USC §103 – Ghoshal and Anderson

The Examiner rejected claims 8-11, 18-22, 25, 32, and 39-42 under 35 U.S.C. 103(a) as being unpatentable over combined teachings of Ghoshal US Patent No. 6,474,074 and Anderson et al. US Patent No. 5,761,0327.

3. Independent claims 39 and 41

Claim 39 recites a thermosyphon having a substantially full evaporator at all orientations, with performance also being substantially independent of orientation. Claim 41 recites such a thermosyphon as part of a cooling enhanced electronic component.

The Examiner incorrectly asserts that Anderson states that its evaporator is substantially full of liquid coolant over a range of angles. Rather, Anderson states that the *wicking member/manifold 102* is *operable* with respect to any orientation (see col. 4, lines 3-5 and 33-38). Anderson's wicking manifold operates through capillary action in the wicking structure, and purports to spread the liquid, indicating that the evaporator region is less than full. To state that the wicking member/manifold is operable at any angle does not mean that the evaporator is substantially full at any angle. Keeping the evaporator substantially full is not disclosed in either reference. Anderson discloses nothing about how to keep an evaporator substantially full at any orientation, and neither does Ghoshal, since in Ghoshal the evaporator cannot be substantially full and still function.

The present invention, however, teaches a thermosyphon that is substantially full at all orientations. None of the cited references teach or suggest such a design criterion.

There is no motivation or suggestion to combine Ghoshal and Anderson, nor is there any expectation of success, as Ghoshal cannot have a substantially full evaporator and have performance that is orientation dependent, and the combination does not teach or suggest all the claim limitations. As no *prima facie* case of obviousness exists,

claims 39 and 41 are nonobvious and allowable over the combination of Ghoshal and Anderson

4. Dependent claims 8-11, 18-22, 25, 32, 40, and 42

Because claims 8-11, 18-22, 25, and 32 depend from allowable claim 1 as amended through one or more other allowable claims, claim 40 depends from allowable claim 39, and claim 42 depends from allowable claim 41, and respectively add limitations thereto, these claims are allowable. For additional reasons set forth below that demonstrate that there is no *prima facie* case of obviousness, claims 8, 11, 18-22, 25, 32, 40, 42, are allowable.

4.a. Claim 8

A grooved boiling enhancement structure is provided in claim 8. There is no suggestion or motivation to combine Ghoshal and Anderson to achieve Applicant's invention. As previously stated for claim 7 in paragraph 2.a. above, in Ghoshal *"Any con figuration may be used as long as the hot points terminate at a tapered point"* (see col. 4, lines 34-36; emphasis added; see also Ghoshal's independent claims (1, 21, and 29), all requiring hot point elements 250). Ghoshal therefore prohibits the use of Anderson's structure, and claim 8 is nonobvious in view of the cited references.

In addition, Anderson's wicking manifold 102 is used to spread liquid in the evaporator, and is purportedly able to do this at any orientation. Applicant's structure, however, is used mainly for trapping vapor to provide active nucleation sites for boiling.

and is not used to ensure orientation independent performance of the thermosyphon heat spreader. There is no suggestion in either Ghoshal or Anderson to combine Anderson's structure for spreading liquid to make a site for vapor nucleation. Again, claim 8 is nonobvious.

4.b. Claim 11

Claim 11 recites a boiling enhancement structure of open-celled foam. For similar reasons as those discussed for claim 8 in paragraph 4.a. above, Ghoshal cannot be combined with Anderson to include such a structure in place of its "hot point" elements 250. Accordingly, claim 11 is nonobvious in view of the cited references.

4.c. Claims 18-22, 25, 32, 40, 42

These claims relate to the level of liquid in the evaporator for various orientations. Please refer to paragraph 3 above. For the same reasons as those given for claims 39 and 41 in paragraph 3, these claims are nonobvious and allowable.

Claim Rejections - 35 USC §103 – Ghoshal and Paal

The Examiner rejected claim 14 under 35 U.S.C. 103(a) as being unpatentable over combined teachings of Ghoshal US Patent No. 6,474,074 and Paal US Patent No 5,051,814. Claim 14 is allowable as it depends from allowable claim 12, which depends from allowable claim 1, and adds limitations thereto.

Claim Rejections - 35 USC §103 – Ghoshal and Brezezinski

Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over combined teachings of Ghoshal US Patent No. 6,474,074 and Brzezinski US Patent No. 5,323,292. Claim 23 depends from allowable claims 12 and then 1, and adds limitations thereto. For this and the reasons below that show there is no *prima facie* case of obviousness, claim 23 is allowable over the cited references.

5. Claim 23

Brezezinski does not include an evaporator or evaporator plate, contrary to the Examiner's assertion. Instead there are two heat sinks provided (see Figure 1; col. 3, line 62 to col. 4, line 4 (two heat sinks); col. 5, lines 29-38 (thermally conductive fluid 58 fills the chamber formed by the first heat sink and the metallic membrane 56 – this is not an evaporator)). The fluid 58 provides a thermal path and does not evaporate.

Further Brezezinski does not disclose the walls as in claim 23. Claim 23 claims a condenser, which does not exist in Brezezinski, and more specifically, the cross-sectional shape of a condenser. Nor is such a shape disclosed in Ghoshal. This shape is shown in Applicant's figures 3, 7, 8, and 13. The combined references lack all the limitations of claim 23, fail to motivate or suggest combining the references, and have no expectation of success in resulting in Applicant's invention. Accordingly, claim 23 in nonobvious in view of Ghoshal and Brezezinski.

Claim Rejections - 35 USC §103 – Design Choice

The Examiner rejected claims 24, 26, 29, and 36 on the basis of design choice. Because these claims depend from allowable claim 1 as amended through one or more other allowable claims, and respectively add limitations thereto, these claims are allowable. For additional reasons set forth below that show there is no *prima facie* case of obviousness, claims 26, 29, and 36 are allowable.

6. Claims 26, 29, 36

Planar shapes of rectangular (claim 28) and of square (claims 29 and 36) are asserted by the Examiner to be simply a matter of design choice. The Applicant is quoted as stating "the feature may be any shape as desired to suit a particular application or manufacturing advantage."

The above quote is true, but is taken out of context. In the application, it is included as a delimiting phrase to explain that a thermosyphon may have any planar shape and yet still fall within the scope of Applicant's invention if it meets other requirements.

A variety of planar shapes may be used in accordance with the present invention. To be an embodiment of the present invention according to claims 26, 29, and 36, however, a thermosyphon of any planar shape must have dimensions that keep the evaporator substantially full at any orientation. A planar shape has a great impact on the overall evaporator and condenser dimensions (outside the plane). Therefore, selecting a planar shape is not simply a matter of design choice.

Claim Rejections - 35 USC §103 – Ghoshal and Munekawa

The Examiner rejected claims 27, 28, 30, 31, 37, and 38 under 35 U.S.C. 103(a) as being unpatentable over combined teachings of Ghoshal US Patent No. 6,474,074 and Munekawa et al. US Patent No. 5,076,351. Because claims 27, 28, 30, 31, 37, and 38 depend from allowable claim 1 as amended through one or more other allowable claims, and respectively add limitations thereto, these claims are allowable. These claims are also allowable for the additional reasons set forth below showing that there is no *prima facie* case of obviousness.

7. Claims 27, 28, 30, 31, 37, and 38

These claims provide dimensional requirements for thermosyphons according to the present invention. Munekawa is directed to a heat pipe and is inapplicable to Applicant's invention. The shapes of heat pipes may vary (see Applicant's application p. 2, lines 7-9). Evaporators and condensers in heat pipes may be sized as known to one of ordinary skill in the art. Unlike in Applicant's invention, Munekawa's condenser height is irrelevant to the liquid coolant volume and to the height of the evaporator. No liquid coolant resides in Munekawa's condenser. Further, the relationship between the Munekawa evaporator and the condenser has nothing to do with the orientation-independence of the heat pipe.

A variety of variables must be considered in order to size and fill the thermosypon in accordance with Applicant's invention. Contrary to the Examiner's assertion,

selecting the height of the condenser and evaporator, as well as the variables of evaporator and condenser lengths, is neither obvious nor routine skill in the art. None of the references cited by the Examiner teaches or suggests such a geometric configuration. None has the purpose or result of providing an orientation-independent thermosyphon, achieved by maintaining a substantially full evaporator.

The combined references lack reference to limitations of these claims, and the subject matter between the two references is too different to be able to combine and achieve the Applicant's invention with any expectation of success. Nor is there any suggestion or motivation to combine the references. Claims 27, 28, 30, 31, 37, and 38 are nonobvious over the cited references.

Serial No.: 09/828,564

If the Examiner has any questions about the present Reply or anticipates finally rejecting any claim of the present application, a telephone interview is respectfully requested.

As the rejections entered by the Examiner in the Official Action dated January 28, 2003 have been shown to be inapplicable, reconsideration and allowance of claims 1-3, 7-12, 14, 17-32, and 36-44, and passage of these claims to issue, is hereby respectfully requested. Further, as the Examiner previously agreed that allowable claim 1 is generic with respect to claims 1-42 and allowable claim 39 is generic with respect to claims 10-12, it is requested that the withdrawn claims be reconsidered and passed to issue.

Respectfully submitted,

Date: April 25, 2003

Matthew W. Witsil
Registration No. 47,183
Moore & Van Allen
Attorney for Applicants
2200 West Main Street, Suite 800
Durham, NC 27705
(919) 286-8000 (telephone)
(919) 286-8199 (facsimile)